IN THE SPECIFICATION:

Please amend paragraphs [002], [008], [012] - [017], [024] - [031], [033] -[035], [037], [038], [041] – [043], [046], [049], and [057] – [059] of the specification as shown below, in which deleted terms are shown with strikethrough and/or double brackets, and added terms are shown with underscoring.

Paragraph [002]

In the ranging of an object, that is a measurement of the distance from the observing point to the object, stereo cameras such as CCD (Charge Coupled Devices) image sensor cameras or CMOS image sensor cameras are widely used. However in the use of such stereo cameras, various measurement errors in the system are accumulated to affect the resultant precision of the ranging measurement.

Paragraph [008]

The distortion depends on the distance from the camera to [[the]] a target object. Therefore, it is necessary to fix and determine the lens distortion and to measure the distance to the object for the purpose of removing the distortion of the images which are to be used for advertisement or art appreciation. These parameters such as the lens distortion and the distance to the object serve to make an appropriate distortion correction. However, the distortion correction is not uniquely determined only by distortion information of the lens system since the distortion depends on the distance to the object which is unknown in the acquired image which is taken through the lens.

Paragraph [012]

For the ranging apparatus regarding the present invention, plural distortion correction means are made for the ranging distances of the object in a progressive[[ly]] set as 10-20 cm, 20-35 cm, 35-55 cm, etc. The corrective computation means carries out to generate plural corrected images computed by using all distortion correction means provided for the progressively set ranging distances. In this computation, the plurality of the corrected images equals to the number of corrective computation means multiplied by the quantity of cameras used for the image acquisition.

Among these corrected images, the corrected image which is most appropriately corrected is selected by a corrected image selection means. The corrected image selected in this process is used for the determination of the ranging distance which is computed by a ranging computation means. The precise distance can be finally obtained after this series of processes.

Paragraph [013]

Further in the present invention, an image acquired by one of the plural cameras is corrected to remove the distortion therein and can be used as a reference image thereafter. Comparison images are created by the correction, being corrected against the same ranging distance, done for the image acquired by another of the plural cameras. The positions of the picture elements that compose and present the object in the reference image are specified. Furthermore, the object is specified in the picture elements which are shifted by the parallaxes corresponding to the ranging distances progressively set for the distortion correction. The corrected image that shows the best coincidency between the picture elements composing the object on the reference image and those composing the object on the corrected image is selected.

Paragraph [014]

Further in the present invention, the picture elements of the object in the reference image are specified and the object image is searched on the position of the picture elements which locates apart by the parallaxes against the position defined on the comparison image. The smaller the parallax is the further the ranging distance is or reverse wise. For the comparison image, the distance of the object of which image is acquired is set in a certain range where the image correction distance is done for the distance. Therefore, if the comparison image is appropriate, the image of the object should locate[[s]] in the position of the picture element that is shifted by the parallax having a range corresponding to the ranging distance of the image acquisition. The coincidence regarding the object between those on the acquired image and those on the shifted picture elements is evaluated for every comparison image and the coincidence shows a peak for the comparison image that has the most appropriate distortion correction. This results into a determination of the optimum corrected image.

Paragraph [015]

According to the apparatus that has the means to realize the above determination sequence and method, an optimum comparison image, that is, the image corrected by appropriate[[ly]] correction means can be selected by searching the object in only limited picture elements where the coincidence is only evaluated.

Paragraph [016]

The present invention ~~consists of~~ <u>comprises</u> several steps to compute the ranging distance. The first step is to acquire the image of [[the]] <u>a target</u> object by using plural cameras. The second step is to determine plural corrected images by computing to eliminate the distortion with the distortion correction means obtained for the ranging distances progressively set on beforehand. The third step is to select the corrected image that has the least distortion. The fourth step to compute the ranging distance of the object in the corrected image based on the corrected image.

Paragraph [017]

When this method is applied to the determination of the ranging distance, the effects of the measurement step are obtained as follows. Plural images can be acquired by the plural cameras in the <u>first</u> step [[1]]. Plural corrected images can be obtained after the correction for each acquired image done by all of the distortion correction means in the second step. The corrected image that has the least distortion among the plural corrected images is selected in the third step. The distance of the object is computed on the basis of corrected images that are appropriately corrected for the distortion in the fourth step.

Paragraph [024]

FIG. 4 [[shows]] <u>is</u> a diagram that shows an example of the distortion correction and the selection of the corrected image.

Paragraph [025]

FIG. 5 [[shows]] <u>is a chart showing</u> the results of coincidence against the corrected images.

Paragraph [026]

FIG. 6 [[shows]] is a diagram showing the spatial relation of the viewing angles to determine the ranging distance of the object.

Paragraph [027]

FIG. 7 is the flow chart that shows a process to compute[[r]] the ranging distance.

Paragraph [028]

FIG. 8 [[shows]] is a chart showing the correction errors generated after the conventional calibration.

Paragraph [029]

~~We will explain the~~ An explanation of an embodiment of the present invention is set forth in relation to the appended ~~using the~~ figures.

Paragraph [030]

FIG. 1 shows the functional block diagram of an embodiment of the ranging apparatus. The ranging apparatus 1 comprises cameras 10, an image input means 20, a memory device 30, a corrective computation means 40, a corrected image selection means 50 and a ranging computation means 60.

Paragraph [031]

The cameras 10 compose of a right camera CR and a left camera CL [[put in]] placed side by side and are directed to the object. The cameras CR and CL are constructed with lens systems and CCD image sensors. The view is converged on to the CCD image sensor through the lens system as an image. Then, the image signal is sent out to the image input means 20. The present embodiment shows two cameras, however it is possible to use three or more cameras for the ranging apparatus.

Paragraph [033]

The memory device 30 is a hard disk drive that stores and retrieves the data base necessary for the operation of the ranging apparatus and the image data under processing and that works as a system disk for the computer operation as well. The memory device 30 stores a distortion correction table 31 that is used for eliminating the distortion of the image acquired by the cameras CR and CL and a vector or directional mapping table 32 that is used for the computation of the distance to the object.

Paragraph [034]

The distortion correction table 31 shows the shift necessary for the distortion correction in a unit of picture element (du, dv) against the position (u, v) on the image data acquired by the camera CR and CL picture. This distortion correction table 31 is made for each of cameras CR and CL. Since the distortion correction depends on the distance to the object, the distortion correction table 31 has been made against every distance in a way of progressive step that is predetermined for each of the cameras CR and CL. For example, the distances as 0.1 – 0.2 meters, 0.2 -0.3 meters, 0.35 – 0.55 meters, ..., 30 meters and infinity are selected and the distortion correction tables are made for all of these for progressively ~~determined~~ determining the distance.

Paragraph [035]

The degree of the correction by using the distortion correction table is, for example, shown in FIG. 3. Let the image of checker pattern 90 be acquired by the camera 10 in the middle range distance and the barrel distortion be generated, an appropriate correction is obtained when a distortion correction table made for a middle range distance is used for the distortion correction. On the other hand, an over-correction such as a pin cushion distortion is obtained as shown in the checker pattern 93 when a distortion correction table made for a long range distance is used for the distortion correction and an under-correction such as a barrel distortion is obtained as shown in the checker pattern 91 when a distortion correction table made for a short range distance is used for the distortion correction.

Paragraph [037]

The directional mapping table 32 is, as shown in FIG. 2(b), to show the correspondence between the coordinative position (u', v') of the picture element on the corrected image and the incidental angle of the light, being emitted from a light spot in the space to be viewed by the cameras [[30]] 10, to a reference point on the optical axis which is penetrating a certain reference plane in the optical system of the cameras [[30]] 10. The definition of the incidental angles $\alpha 1$, $\alpha 2$, γ is as follows.

$\alpha 1$: the horizontal deviation angle from the optical axis MR of the camera CR regarding the horizontal plane projection of the vector D1 expanding from the reference point to the object OB

$\alpha 2$: the vertical deviation angle from the optical axis MR of the camera CR regarding the vertical plane projection of the vector D1 expanding from the reference point to the object OB

γ: the horizontal deviation angle from the optical axis ML of the camera CL regarding the horizontal plane projection of the vector D1 expanding from the reference point to the object OB

Paragraph [038]

The corrective computation means 40 eliminates the distortion of each acquired image taken by the camera CR or CL by using the distortion correction tables 31. The distortion correction tables 31 are made for each of the cameras CR and CL, and each of the progressively predetermined ranging distances. The corrected images are made for all these [[all]] distances and for these cameras [[31]] 10.

Paragraph [041]

As shown in FIG. 4, the corrected images of the right acquired image IR by using the distortion correction table 31 are called reference images as MR1 to MR30 and the corrected images of the left acquired image IL are called comparison image ML1 to ML30. The corrected image M1

to M30 are generated by the different distortion correction tables 31 by means of the corrective computation means. For example, the corrected image M1 is generated by using a short ranging distance table for 0.1 to 0.2 meters, ~~the corrected image M1 is generated by using a short ranging distance table for 0.1 to 0.2 meters,~~ the corrected image M15 is generated by using a middle ranging distance table for 2.0 to 3.0 meters and the corrected image M30 is generated by using a long ranging distance table for 30 meters to infinity. The suffix numbers of the reference images and the comparison images imply that the same distortion correction under the same ranging distance of the object is applied for both the reference image and the comparison image if the suffix number is same.

Paragraph [042]

The corrected images M1 to M30 are corrected by the distortion correction tables 31 which are made for different ranging distances. Therefore, if a certain corrected image Mn is corrected by the distortion table 31 made for an appropriate ranging distance, the object OB taken in the reference image MRn (n: an integer for 1 to 30) should be taken at a shift of the parallax in the right direction in the corresponding comparison image MLn. Therefore, it is possible to search the object in the picture elements which are deviated by the shift amount of the parallax explained above and to evaluate the appropriateness of the corrected image Mn by quantitative analysis of the coincidence of the object.

Paragraph [043]

The process to compute the coincidence is carried out as follows. FIG. 4 shows an example to explain the coincidence computation. The reference image MR1 is corrected by the distortion correction table 31 with ranging distance of 0.1 to 0.2 meters. If the image of the object OB locates in (u1, v1) in the reference image MR1, the object OB locates with a shift of parallax in the comparison image. Therefore the searching range SA1 is largely shifted in the right direction against the location of the picture element OB' in the comparison image ML1 because the OB location as (u1, v1) is mapped in such a shifted area if the ranging distance is for 0.1 to 0.2 meters. The height of the searching range SA1 is determined to cover[[s]] the object OB in the comparison image. It is not necessary to set large height since there is no parallax in the vertical direction.

Paragraph [046]

The heights of the searching range SA15 and SA30 are determined to cover[[s]] the object OB in the comparison image. It is not necessary to set large height since there is no parallax in the vertical direction.

Paragraph [049]

[[The]] With reference to Fig. 6, the spatial position (Px, Py, Pz) of the object is calculated using the following equations.

$$Px = (x1 \tan\alpha 1 - y1 - x2 \tan\alpha 2 + y2) / (\tan\alpha 1 + \tan\alpha 2) \quad \ldots (1)$$

$$Py = (Px - x1) \tan\alpha 1 + y1 \quad \ldots (2)$$

$$Pz = (Px - x1) \tan\gamma + z1 \quad \ldots (3)$$

where, (x1, y1, z1) is a reference point of the optical system of the camera CR and (x2, y2, z2) is that of the camera CL. In this embodiment, the quantity (Px – x1) is the ranging distance of the object OB.

Paragraph [057]

According to the ranging apparatus in the present embodiment, the precise ranging distance can be determined [[even]] from the images of the object acquired by the cameras CR and CL since the most appropriate correction is applied to the acquired image of the object in response to the distance thereto. In [[the]] selecting one of the corrected images M1 to M30, it is possible to select the corrected image Mn by small amount of computation since the coincidence computation is carried over the small areas as SA1 to SA30 (determined by the parallax of the two cameras) where the object should exist if the corrected images M1 to M30 are appropriately corrected.

Paragraph [058]

Although there [[have]] has been disclosed what [[are]] is the ~~patent~~ present embodiment of the invention, it will be understood by persons skilled in the art that variations and modifications may be made thereto without departing from the scope of the invention, which is indicated by the appended claims. For example, the object is not limited to the marker which is selected for the object OB in the present embodiment but the persons' figures, the still objects and other materials can be adopted. In order to specify these objects of which images are acquired by the camera CR and CL, a contour extraction means may be used.

Paragraph [059]

As ~~have been explaining~~ explained, it is possible to precisely compute the ranging distance of the object by using the images acquired by the cameras since the deformation of the image is appropriately corrected by this invention.